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TECHNICAL MEMORANDUM

To: Mr. Richard Franklin, U.S. Environmental Protection Agency

From: Steve Fuller, TechLaw, Inc.

Subject: Evaluation of the Need for a Biological Assessment in the Engineering Evaluation and Cost Analysis for the Former USS Washtenaw County (LST-1166) Rev.1
TO-001-10-12-0040-DCN1044

EXECUTIVE SUMMARY

This Technical Memorandum was prepared to assess whether a Biological Assessment will be needed in the Engineering Evaluation and Cost Analysis (EE/CA) for the Former USS Washtenaw County (LST-1166). The assessment involved the review of historical and background information on LST-1166 itself, as well as information regarding the environmental settings involved in the disposal of the LST-1166 in conjunction with information from a detailed study regarding the impacts of deep sea disposal of a the Navy ship (PEO Ships, 2006b). The conclusion of the assessment supports that the proposed project will have no adverse effect on the species and critical habitat identified in Section 4.0 during the removal and transportation elements of the action or on the benthic and pelagic communities following deep ocean disposal. Further, this conclusion indicates that all effects are beneficial, insignificant, or discountable within the Columbia River and at sea. As indicated in the effects evaluation, a majority of the wastes and paint have been removed and residual levels will be entombed following EPA's *National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs* (EPA, 2006). As a result, through the use of BMPs, the potential for ecological exposure to vessel-related contaminants is expected to be minimal.

1.0 BACKGROUND/HISTORY

The purpose of this Technical Memorandum is to address whether a Biological Assessment is needed in the Engineering Evaluation and Cost Analysis (EE/CA) for the deep ocean disposal of the Former USS Washtenaw County, a 2,590-ton LST 1166 class tank landing ship, hereafter referred to as LST-1166 . During U.S. EPA inspections of the LST-1166 vessel in January and March 2010, U.S. EPA personnel observed corroded and flaking paint throughout the interior and exterior of the vessel (U.S. EPA, 2011). Paint chips were observed littering most of the horizontal surfaces and deck floors. The paint may potentially flake off the external surfaces of the hull and fall into the Columbia River if the hull were to come into contact with abrasive force. Correspondence between the U.S.Coast Guard (USCG) and the U.S. EPA confirmed that the interior paint contained both lead and polychlorinated biphenyl compounds

(PCBs), while the exterior paint contains only lead ranging from 3.42 milligrams per kilogram (mg/kg) to 71,500 mg/kg. PCBs present in some of the interior paint ranged from < 0.5 mg/kg to 72.6 mg/kg. Wiring on the vessel is asbestos-insulated and this insulation also contains hazardous amounts of solid PCBs ranging from <0.5 mg/kg to 2,160 mg/kg. The vessel also contained polyurethane foam in several rooms and interior spaces. In addition, an unknown type of oil globules and beds were observed floating on the surface of approximately 20 feet of water that has flooded the lower decks of the vessel.

The objectives of the proposed project are to: 1) prevent the potential discharge of oil and potentially hazardous materials from LST-1166 into the Columbia River, 2) prevent and abate the actual or potential contamination of sensitive ecosystems from hazardous substances, and 3) prevent and abate potential impacts of marine biological resources if the ultimate disposal location of the LST-1166 is at sea.

2.0 PROJECT DESCRIPTION

The EE/CA considers four alternatives to meet the project objectives

- Alternative 1: Sealed and Berthed In Place
- Alternative 2: Ocean Disposal under the MPRSA with Full Decontamination and TSCA PCB Bulk Product Waste Risk-Based Disposal Approval
- Alternative 3: Ocean Disposal with Full Decontamination and TSCA 9b Finding for Disposal of PCBs under the Marine Protection, Research, and Sanctuaries Act (MPRSA)
- Alternative 4: Decontamination, Dismantling and Recycle/Disposal (Shipbreaking)

A summary of the alternatives follows.

2.1 Alternative 1: Sealed and Berthed In Place

Under this alternative, the following activities are planned:

1. Pre-removal structural assessment and inspection
   The pre-removal inspection and assessment of the vessel will include evaluation of the structural integrity of various areas (e.g., decks, hull, superstructure, etc.). It will also include inspection of environmental conditions in and outside of the vessel. The inspection will cover areas that could not be inspected during previous inspections. The information generated from the pre-removal assessment and inspection will be used to develop or finalize the removal design work plan and for health and safety. The results of the structural assessment will also identify any areas of the vessel that would require reinforcing before berthing in-place (e.g., determine the adequacy of the moorings).

2. Removal and disposal of approximately 2,000 pounds of solid/hazardous waste.
   Solid and hazardous wastes that have been placed in 55-gallon drums will be loaded on trucks and transported to an off-site permitted landfill for disposal.

3. Removal and disposal of approximately 600 pounds of loose, friable paint chips.

Loose, friable paint chips will be vacuumed from floors and surfaces of the interior of the vessel. A high efficiency particulate air (HEPA)-equipped vacuum will be used for this cleanup. The waste will be collected in 55-gallon drums which will be transported by trucks to an off-site permitted landfill for disposal.

4. Removal and disposal of approximately 40,000 yards of foam (non-hazardous).
   During the inspection of the vessel in 2010 by the U.S. EPA, it was observed that trespassers had exposed and removed foam in certain areas of the vessel. Polyurethane foam will be restricted in closed compartments in order to successfully scuttle the vessel at the bottom of the ocean. All loose and exposed foam will be removed from the vessel. It is estimated that approximately 40,000 cubic yards of foam needs to be removed from the vessel. The removed foam will be transported by trucks to a non-hazardous waste landfill.

5. Removal and treatment of 500,000 gallons of non-oily water
   U.S. EPA inspection of the vessel in 2010 indicated the presence of standing water (20 feet deep) in the lower two decks due to a broken seal (EPA, 2010a). The water will be pumped out through a carbon filter to remove suspended solids and discharged back to the river. It is anticipated that a small amount of sludge may be generated and will be disposed off-site at a permitted non-hazardous landfill. The seal will be inspected and repaired to ensure water is removed to the extent practicable.

In addition, all remaining equipment will be secured or removed where practical and all hatches, doors, portholes and other opening will be sealed prior to berthing in-place.

Finally, all solid/hazardous wastes removed will be disposed off-site at a permitted treatment, storage and disposal (TSD) facility in accordance with state and federal laws. Paint chip removal will be done to the greatest extent practicable. After the removal and disposal activities, all remaining equipment will be secured or removed where practical and all hatches, doors, portholes and other opening will be sealed prior to berthing in-place.

The estimated time frame for Alternative 1 is less than six months.

2.2 Alternative 2: Ocean Disposal under the MPRSA with Full Decontamination and TSCA PCB Bulk Product Waste Risk-Based Disposal Approval and Alternative 3: Ocean Disposal with Full Decontamination and TSCA 9b Finding for Disposal of PCBs under the Marine Protection, Research, and Sanctuaries Act (MPRSA)

The following activities will be performed to prepare the vessel for ocean disposal under Alternatives 2 and 3, in addition to the activities described in Alternative 1.

1. Preparation of deck and superstructure
2. Preparation of below deck
3. Preparation of hull

The above activities include removing or securing all loose equipment, removing any residual oils in the equipment, and generally removing or securing any loose items that could become floating debris during ocean disposal. On the deck and lower tank transport deck, EPA observed engines, generators cables, winches, girders, several boom arms and other assorted equipment that appeared capable of detaching from the vessel during disposal operations and becoming floating debris. The equipment will be removed, welded or caged to the vessel before the vessel can be scuttled. Some of the equipment may contain residual oils and will be inspected; if residual oils are present, they will be removed. In addition, this alternative includes complete removal of all paint and bulk wastes containing PCB. The estimated timeframe for completion of the removal activities for Alternative 2 could take up to three years due to the statutory requirements for risk based disposal approval authority. Alternative 3 uses the authority under TSCA for disposal of PCBs under the Marine Protection, Research and Sanctuaries Act and could be accomplished in 7 months.

2.3 Alternative 4: Decontamination, Dismantling and Recycle/Disposal (Shipbreaking)

In Alternative 4, Decontamination, Dismantling and Recycle/Disposal (Shipbreaking), the vessel will undergo:

1. Pre-removal structural assessment and inspection
   The pre-removal inspection and assessment of the vessel will include evaluation of the structural integrity of various areas (e.g., decks, hull, superstructure, etc.). It will also include inspection of environmental conditions in and outside of the vessel. The inspection will cover areas that could not be inspected during previous inspections. The information generated from the pre-removal assessment and inspection will be used to develop or finalize the removal design work plan and for health and safety. The results of the structural assessment will also identify any areas of the vessel that would require reinforcing before the vessel is towed.

2. Removal and treatment of 500,000 gallons of non-oily water
   U.S. EPA inspection of the vessel in 2010 indicated the presence of standing water (20 feet deep) in the lower two decks due to a broken seal (EPA, 2010a). The water will be pumped out through a carbon filter to remove suspended solids and discharged back to the river. It is anticipated that a small amount of sludge may be generated and will be disposed off-site at a permitted non-hazardous landfill. The seal will be inspected and repaired to ensure water is removed to the extent necessary for towing.

3. After removal and treatment of approximately 500,000 gallons of non-oily water and securing equipment onboard, the vessel will be then towed using tugs to a dry dock. This activity will be conducted as described under Alternative 2.

4. Removal of the solid and hazardous materials outlined in Alternatives 1 and 2 and 3 will be carried out at the dry dock.

5. After PCB removal, the superstructure and any other recyclable materials will be segregated from non-recyclable solid wastes for recycling/disposal.

6. It is anticipated that approximately 2,400 tons of steel/metal will be recycled.

The estimated duration of Alternative 4 is seven months.

3.0 DESCRIPTION OF THE PROJECT AREA

The LST-1166 is currently located at Dibblee Point, along the south bank of the Columbia River, south of Lord Island at River mile No. 63 as shown on Figure 1. It is located approximately 4.5 miles west-northwest of Rainier, Oregon and approximately 1.25 miles downstream and south of Longview, Washington. LST-1166 is located in the DELEMA United States Geologic Service (USGS) topographic map quadrangle at 46° 7’17.82” N 123° 0’52.24” W.

The Project Area consists of the reach of the Columbia River from the current location of LST-1166 upstream to Portland Harbor and downstream and out into the Pacific Ocean about 65 miles. For the alternatives involving the transport of the LS-1166 to the Portland Harbor or to the Pacific Ocean, the Project Area traverses Columbia and Clatsop counties in Oregon and the Pacific, Wahkiakum, and Cowlitz counties in Washington.

4.0 SPECIES/CRITICAL HABITAT CONSIDERED

Because the initial phase of the project involves the removal and disposal of hazardous and non-hazardous materials from the LST-1166, the project may potentially impact the following ESA-listed anadromous and marine species that may occur in the area:

Federal Threatened, Endangered, Proposed Threatened or Proposed Endangered Species (National Oceanic and Atmospheric Administration [NOAA], 2009); NOAA, 2011; U.S. Fish and Wildlife Service [USFWS], 2011a and 2011b)

Steelhead (*Onchorhynchus mykiss*) **T**
Chinook salmon (*Oncorhynchus tshawytscha*) **T**
Chum salmon (*Onchorhynchus keta*) **T**
Coho (*Oncorhynchus kisutch*) T
Green sturgeon (*Acepenser medirostris*) **T**
Eulachon (*Thaleichthys pacificus*) **T**
Bull trout (*Salvelinus confluentus* pop 2) **T**
Loggerhead sea turtle (*Caretta caretta*) **E**
Green sea turtle (*Chelonia mydas*) **T**
Leatherback sea turtle (*Dermochelys coriacea*) **E**
Olive (=Pacific) sea turtle (*Lepidochelys olivacea*) **T**
Blue whale (*Balaenoptera musculus*) **E**

Humpback whale (*Megaptera novaeangliae*) **E**
Sperm whale (*Physeter macrocephalus*) **E**
Orca whale (*Orcinus orca*) **E**
Stellar sea lion (*Eumetopias jubatus*) **E**

T = Threatened
E = Endangered

Federal Candidate Species (USFWS, 2011a and 2011b)

None listed

Federal Species of Concern (USFWS, 2011a and 2011b)

River lamprey (*Lampetra ayresii*)
Pacific lamprey (*Lampetra tridentata*)
Coastal cutthroat trout (*Oncorhynchus clarkii ssp.*)
California floater musssel (*Anodonta californiensis*)

Federal Critical Habitat

The action addressed within this biological assessment falls within Critical Habitat for the Lower Columbia River. Final rulings on Critical Habitat have been established by the USFWS for the following species:

- Steelhead (*Oncorhynchus mykiss*) on September 2, 2005 (Federal Register, Vol. 70, No. 170)
- Chinook salmon *(Oncorhynchus tshawytscha)* on September 2, 2005 (Federal Register, Vol. 70, No. 170)
- Chum salmon (*Onchorhynchus keta*) on September 2, 2005 (Federal Register, Vol. 70, No. 170)
- Bull Trout (*Salvelinus confluentus*) on October 18, 2010 (Federal Register, Volume 75, Number 200)

The Columbia River supports a wide array of fish, wildlife and sensitive environments. No officially designated wilderness areas or wildlife preserves are located in the vicinity of the vessel; however, several species have been listed as endangered for Columbia County and may be found in the vicinity of the vessel (EDR 2011).

The upper, middle, and lower Columbia River populations of Steelhead (*Oncorhynchus mykiss*); the upper and lower Columbia River populations of Chinook salmon (*Oncorhynchus tshawytscha*); and, the Columbia River population of Chum salmon (*Oncorhynchus keta*) have been federally-listed as endangered species (EDR 2011). On the state-level, the river has been designated as critical habitat for Bull Trout (*Salvelinus confluentus*) and Steelhead (*Oncorhynchus mykiss*), and is a migratory pathway crucial for the maintenance of Steelhead (*Oncorhynchus mykiss*) (WA DEP 2003). Lord Island, located north of LST-1166, is designated as a waterfowl use area and wetland habitat (WA DEP 2003). Both Riverine and Palustrine wetland systems are located in the vicinity of the vessel (EDR 2011).

The potential effects that the various disposal alternatives may have on these ecological receptor groups is further evaluated in Section 6.0, Effects Analysis.

5.0 AUTHORITY FOR ACTION

On September 7, 2007, the USCG was notified by local law enforcement authorities that oil was discharging from the LST-1166 into the Columbia River. The USCG immediately conducted an inspection of the ship and confirmed there was a substantial threat of discharge of fuel oil and hazardous substances, due to the deteriorated condition of the vessel and documented evidence of vandalism and theft. During the investigation, the USCG discovered lubricants, solvents, potential asbestos-containing materials (ACM), and lead-based paint on and in the vessel.

On November 13, 2007, the USCG issued an Administrative Order (Order) to the vessel owner, USS Washtenaw County – LST 1166, LLC, to remove all contaminants from the vessel. The owner held a Certificate of Financial Responsibility (COFR), which was issued because the vessel had demonstrated their ability to pay for cleanup and damage costs in the event of a water pollution incident under the Oil Pollution Act (OPA). The COFR was underwritten by Lloyds of London, who hired a contractor to respond to the Order.

On January 15, 2008, the USCG, pursuant to 40 Code of Federal Regulations (CFR) 229.3 for vessel disposal under the Marine Protection, Research and Sanctuaries Act (MPRSA), gave the owner 30 days to submit a comprehensive plan. On February 1, 2008, the EPA Region 10's Ocean Dumping program received a request from the underwriter's contractor seeking authorization to use the EPA Ocean Dumping General Permit (ODGP) to dispose of the LST-1166 at sea. However, on February 15, 2008, the contractor was denied permission because the terms of the ODGP had not been met as the contaminants on the vessel had not been removed to the maximum extent possible, as required. Following dissolution of the LLC, the underwriters discontinued efforts to comply with the USCG orders.

In response to the owner's non-compliance with the Order, from July 2008 to January 2009, the USCG conducted interim removal activities and encapsulated asbestos-containing insulation, surfaces, and piping. Funding for the USCG Removal Action included funds from the Oil Spill Liability Trust Fund (OSLTF) and the Superfund (USCG 2009). The USCG began to pursue a cost recover against the owner, which is currently being pursued by the U.S. Department of Justice (USDOJ).

In January 2010, the USCG contacted EPA's Comprehensive Environmental Response, Compensation, and Liability (CERCLA) program and informed EPA of the USCG's intent to use the ODGP to dispose of the vessel in the ocean or relinquish control of the vessel to EPA for Remedial Action. This contact initiated EPA's involvement with the investigations and actions at the LST-1166 vessel. The USCG has tasked the EPA, under a Pollution Removal Funding Authorization (PRFA), dated September 2, 2010, with preparation of an Engineering Evaluation/Cost Analysis (EE/CA) Report for LST-1166. The EE/CA

Report has been completed as required by 40 CFR 300.415 (b)(4) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and was prepared using Guidance on Conducting Non-Time Critical Removal Actions under CERCLA, EPA/540-R-93-057, dated August 1993 (EPA 1993).

The USCG removed the oils and lubricant from the vessel during an earlier removal action in 2007, eliminating potential exposures to biota.

6.0 EFFECTS ANALYSIS

Degradation of Water Quality in the Columbia River

Impacts from removal activities may potentially result in impacts to riverine biota resulting from degradation of water quality and turbidity in the Columbia River in the vicinity of LST-1166. However, these potential impacts will be mitigated by implementing best management practices during removal of water to allow the vessel to float. Currently, the lower decks of the vessel are flooded due to a leaking seal and the hull rests two feet above the riverbed in 20 feet of water. The process for floating the vessel will involve underwater repair of the seal by divers and then pumping the water out of the vessel. The water in the vessel will be pumped to a granulated activated carbon filtration treatment unit prior to discharge to the river to remove any potential oil or other contaminants. The treated water will meet water quality discharge requirements. The vessel contains approximately 500,000 gallons of water and the pumping rate is expected to average 50 gallons per minute. At that rate, it will take approximately two weeks to drain the vessel and it is estimated that the vessel will rise in the river at a rate of about 0.6 inches per hour. The lifting rate will be imperceptible compared to the velocity of the river's flow and will not result in any measurable turbidity in the water column or affect sediments on the river bed.

Release of Paint Chips and Oils from Vessel

As the vessel deteriorates, chips of lead- based paint on the exterior of the ship may occasionally flake off the hull and superstructure and drop into the river. Anti-fouling (AF) coatings typically are not of concern on vessels that are at least twelve years old and since all the underwater hull area is covered with marine growth, the AF coatings can be left in place without further evaluation, as they are no longer likely to be harmful as indicated by EPA guidance (EPA, 2006). Exterior paint chips containing lead from degraded surfaces, may accumulate in sediments and be ingested by fish or benthic organisms. Indirect exposure may occur through bioaccumulation in the food chain and trophic transfer to avian omnivores, avian piscivores, or wildlife that consumes fish or benthic organisms. However, the high flow rates transport the chips an unknown distance downstream before they are deposited on the sediment. The distance from the vessel is partially controlled by the chip size and water velocity. The USGS measures the annual discharge for the Columbia River at The Dalles, Oregon at River Mile 194. The average annual discharge for 1879-1999 was 86,175,360 gallons per minute. Sand transport in the lower Columbia River is driven by the river discharges. Annually, the lower Columbia River sand transport is highly variable ranging from approximately 0.1 million cubic yards (mcy) in 1926 to over 37 mcy in 1984. Since 1975, the average annual sand transport is about 1.3-mcy/yr (USACE undated). Therefore, based on the environment surrounding the vessel, the probability of significant accumulation of lead-based paint chips in sediments is improbable. Given the random flaking of the exterior paint from the hull, high flow rates and high sedimentation rates in the river, the possibility that paint chips could accumulate in sediment at concentrations presenting a threat to benthic biota appears to be extremely low.

At the ocean disposal location, approximately 1,000 fathoms (6000 feet) below the surface of the ocean, there are no human receptors and impacts to any ecological receptors from lead in paint chips are expected to be minimal. The contamination remaining in the vessel will have minimal impact on the environment based on human health and ecological risk assessments conducted obtained from studies conducted on vessels disposed in shallow reef environments. These studies indicate the fate and transport of lead in paint will not likely leach to the environment under the prevailing pressure, temperature and salinity (Yender 2009), (U.S. Navy Fact Sheet 2011), (PEO Ships 2006a). Therefore, this alternative will have no impact on any potential receptors and is likely more protective for the LST-1166 disposal since the vessel will be scuttled at a depth significantly greater than the shallow reef for which the human health and ecological risk assessments were conducted.

It should be noted that the USCG removed the oils and lubricant from the vessel during an earlier removal action, thereby eliminating potential exposures of biota to these wastes. Further, the ocean disposal location was previously approved and the location is sited in areas that would reduce the exposure potential to human and ecological receptors; as a result, the disposal location is free of:

- shipping lanes;
- restricted military areas;
- areas of poor water quality (e.g., low dissolved oxygen, dredged material disposal sites);
- traditional trawling grounds;
- unstable bottoms;
- areas with extreme currents, or high wave energy;
- existing right-of-ways (e.g., oil and gas pipelines and telecommunication cables);
- sites for purposes that are incompatible with artificial reef development; and
- areas designated as habitat areas of particular concern or special aquatic sites.

Leaching of Chemicals into the Columbia River and the Pacific Ocean

PCBs were historically used in hundreds of industrial and commercial applications until their manufacture was banned in the US in 1979 (EPA, 2010). When released in the environmental, PCBs do not readily break down and therefore may remain for long periods of time cycling between air, water, and soil (EPA, 2010). As a result, PCBs can be carried long distances and have been found in snow and sea water in areas far away from where they were released into the environment. As a consequence, PCBs are found all over the world (EPA, 2010). The leaching of chemicals such as lead and PCBs from the LST-1166 into the Columbia River and the Pacific Ocean are of particular concern since lead and PCBs are known to bio accumulate in organisms and can be transferred through the food chain. Although studies have shown that chemicals, such as heavy metals and PCBs, have a wide-spread presence in fish and shellfish, ecological distributions of chemical concentrations are often not correlated and can be species-specific, suggesting that there are other factors that influence the presence of chemicals in biota (Johnston et al., 2007; Snyder and Karouna-Renier, 2009). These factors may include life history, bioavailability, spatial dispersion of chemicals, and from sources other than the vessels due to the widespread use of both PCBs and lead in industrial operations and components of fuel and oil products.

Investigations of solid materials found onboard older, out of service surface vessels and submarines have been conducted to evaluate the leaching of PCBs found in shipboard components (George, et al. 2006; Johnston, et al., 2006). Leaching experiments were designed to simulate an open system with transport of PCBs away from the solid to preclude PCB saturation in seawater. Results of the studies demonstrated that various shipboard solids attenuate the leaching of PCB to varying degrees and eventually stabilizes at significantly different rates. For the former USS Oriskany, used to create an artificial reef off the coast of Pensacola, Florida, the leach rate of PCBs from bulkhead insulation was determined to leach proportionally more PCBs than the other materials. In contrast, electrical cabling has a very low leach rate and contributed only about 10% of the PCBs expected to be released at steady state (Johnston, et al., 2006).

In the same study, Johnston et al. (2006) estimated future risks from sinking the former USS Oriskany, using a prospective risk model (PRAM, NEHC/SSC-SD 2006a) and a time dynamic model (TDM, NEHC/SSC-SD 2006b) developed to model the release, transport, fate, and bioaccumulation of PCBs leached from solid materials onboard the vessel. The results of the models were used to characterize potential toxicological risk from PCBs to ecological receptors that could reside, feed, and/or forage at the artificial reef. The risk characterization indicated that predicted sediment and water concentrations around the reef showed no indication of risk during the first two years after sinking or in subsequent years. Total PCB exposure levels predicted by the models showed no indication of risk to plants, invertebrates, fishes, sea turtles, and sharks/barracudas that could live, feed, and forage on the reef. The no-effect threshold for total PCB was exceeded for dietary exposure to dolphins, cormorants, and herring gulls, indicating risk, however, it was conservatively assumed that these species would be life-long residents of the reef and would obtain 100 percent (%) of their food requirements from the reef. Thus, it is likely that actual exposures would be much lower. The predominant route of exposure and trophic transfer of PCBs in the food web was through contact with elevated PCB concentrations modeled for the internal vessel water.

Another study involved a screening level ecological risk assessment conducted using data from fish species collected at artificial reefs comprised of decommissioned ships (Johnston, et al., 2003) in shallow waters to evaluate potential exposures to the reef community and indirect exposures through the food chain. Results indicated that tissue residue data for PCBs, lead, and cadmium in tissues of fish and PCBs and lead in invertebrates were higher in samples from the Navy ship reefs than reference reefs. However, most of the tissue data were lower than effects levels for the reef community, suggesting that there was negligible to low risk of exposure to demersal fish and reef invertebrates. For food chain receptors, data from chemical concentrations in prey were below dietary benchmarks, suggesting that there is a low risk of exposure to dolphins and piscivorous birds, and negligible risk of exposure to diving birds. In addition, empirical estimates of PCB leaching rates were used to simulate the leaching of PCBs from one of the ships and to estimate the instantaneous steady state concentration of total PCBs around the ship. The estimated concentrations were compared to PCB water benchmarks and multiplied by bioconcentration factors to estimate the resulting PCB concentration in fish and shellfish. Results indicated that there was negligible risk of exceeding water column or tissue benchmarks for the scenarios evaluated. The investigators concluded that based on findings of negligible to low risk of exposure to PCBs, the creation of artificial reefs with former Navy vessels containing residual PCBs in solid materials does not pose an unacceptable risk in the environment.

While studies on the former USS Oriskany and other ships provide information on release and fate of PCBs in a shallow water environment, a different set of variables affects the fate and transport of PCBs in a deep ocean environment (PEO, 2006b.).

a. **Deep Ocean Ecosystems.** The ocean bottom acts as a trap for sinking and resuspended particles and supports a higher level of metabolic activity than the water immediately above. Biomass for deep-ocean benthos is relatively low in comparison with typical biomass found for shallow coastal regions. In the deep, open ocean, the benthic microfaunal biomass is dominated by filter and deposit feeding organism's mainly consuming settled detritus and carrion. Due to the lack of sunlight or photo-energy sources, plants are non-existent and food for larger predatory vertebrates (e.g. fish) is presumed to be less available than in a littoral environment. Eventually reefs are created from hulks although in the deep ocean, the process may take from years to decades in contrast to the relatively fast establishment of ecosystems at shallow depths. The benthic infaunal community is considered the most important ecological community at risk from contaminants related to the hulk. The impacts from the hulk may potentially affect infaunal communities because of reef effects (the physical presence of the large hard surface structure) and contaminant effects (release of chemicals from the hulk). These changes can result in physical disruption of the habitat, alteration of trophic and biological relationships, and/or the presence of chemicals from the hulk. Both natural and artificial reef structures can significantly affect adjacent soft-bottom communities by altering bottom boundary currents, affecting food supply and changes in sediment grain size and providing habitat for predators that forage on the infauna near the reef, however, this is temporary and over time habitats and ecological communities become re-established

b. **Chemical and Physical Characteristics of PCBs.** Physical chemistry data on PCBs vary but generally PCB aqueous solubilities decrease with increasing level of chlorination (higher molecular weight congeners). Solubility of PCBs has been demonstrated to be five times lower in seawater than corresponding values in distilled water. Additionally solubility of different PCB isomers can vary widely (Dexter and Pavlou, 1978) and solubility can increase exponentially with increasing temperature. Extrapolation of the data to estimate solubilities at deep sea temperatures of 4°C are much lower and range between 0.2 ppb and 1.2 ppb, depending on the isomer, in contrast to predicted solubilities ranging from 6 ppb (Aroclor 1268) to 34 ppb (Aroclor 1254), (Dickhut et al., 1986; Shiu et al., 1997).

   Adsorption and desorption rates of PCBs in the ocean environment are dependent on the PCB mixture and substrata to a great extent. PCBs tend to quickly bind to sediment, once released into an aqueous environment as demonstrated by using clays and natural lake sediments (Di Toro and Horzempa, 1982). The study concluded that sediment-adsorbed PCB fractions may be comprised of both reversibly and permanently bound components but mainly remain bound to sediments.

c. **Biodegradation and Transformation.** It is generally assumed that the photo-degradation rate of PCBs in water is about one-tenth of the photo-degradation rate in the atmosphere (Sinkkonen and Paasivirta, 2000). There is a weak association between temperature and photo-degradation rate of organic compounds in solution. However, an increase in temperature by 10°C may result in a corresponding increase in the biodegradation rate by a factor of 2.2 or as much as 2.5 to 3 (Sinkkonen and Paassivirta, 2000) and decreased degradation may occur with a decrease in temperature. Estimates of biodegradation half-lives for PCBs in sediments and soils vary from several years to decades. Half-lives for different congeners have been reported on the order of 10 to 20 years although the rate and extent of degradation is highly site-specific and dependent on factors such as initial PCB concentrations, depth, temperature, other contaminant species, and nutrients present. Another study (Williams and May, 1997) has shown that microbial aerobic degradation of sediments from the Hudson River spiked with Aroclor 1242 can occur at temperatures as low as 4°C within six weeks. This suggests that degradation at such low temperatures is possible in a deep ocean environment although more slowly than in warmer waters.

A study of ecological impacts from deep ocean disposal has been conducted for the ex-AGERHOLM, a World War II-era destroyer sunk in the deep ocean during training and weapons testing as part of the Navy's deep water sinking exercise (SINKEX) in June 1982 (PEO Ships, 2006b). The vessel is sunk in 2,750 feet of water about 120 nautical miles off the coast of San Diego, California. Although the ex-AGERHOLM represents a single sunken ship, the site is considered representative of the types of ships of that class, age, and degree of preparation used as expendable targets in the pre-1990 SINKEX program. The ex-AGERHOLM was investigated to assess ecological impacts to the deep-sea benthic, epibenthic, and pelagic receptors at the site to meet the regulatory requirements identified by the U.S. EPA for conducting SINKEX missions in deep water off the continental shelf. The study was based on an extensive literature review, PCB leach rate study, and field investigation using multiple lines of evidence to determine if potential contaminants of concern: 1) were released from the representative sunken naval vessel, and if so, 2) whether they have adversely impacted the adjacent marine environment. In addition to PCBs, the study also investigated metals and polycyclic aromatic hydrocarbons (PAHs). The ex-AGERHOLM is the only deep-water site with known PCB source data that has been studied to date.

Primary lines of evidence in the ex-AGERHOLM study were: 1) PCB chemistry in sediments comparing the PCB concentrations in the areas in the vicinity of the sunken hulk compared to a reference sites; 2) sediment acute and chronic toxicity bioassays, and 3) sediment bioaccumulation analyses. Results of the sediment chemistry sampling indicated that although the PCB concentrations were about twice as high as PCB concentrations measured from reference samples, the differences were not statistically significant and all sediment PCB concentrations were below the Effects Range-Low (ERL), the concentration of a chemical below which adverse biological effects are rarely observed. Sediment toxicity tests showed that amphipod survival tests resulted in survival values of 83% for the ship site and 93% for the reference site. Since biological significance was defined as greater than 20% reduction in survival relative to controls (USEPA/USACE 1991), the result was considered "not significant". Results of *Neanthes* (worm) chronic 28-day survival and growth tests also did not show statistically significant differences between the ship site and reference sites. The potential for PCBs to accumulate in the food chain was conducted using bioaccumulation tests for the *Macoma* (clam) and *Nephytys* (worm). There were no statistical differences at the $p<0.05$ levels for *Macoma* or *Nephtys* when data were compared from the ship site and the reference locations. However, at one particular station near the ship's stern, the highest PCB concentrations for both *Macoma* and *Nephtys* were notably elevated.

Additional lines of evidence used in the ex-AGERHOLM investigation were evaluated to more completely assess potential risks at the site. These additional lines of evidence included a benthic community analysis, evaluation of secondary chemicals of concern – metals and PAHs; and, an evaluation of the spatial distribution of PCBs. There were no statistically significant difference in measures of diversity, richness, and abundance between the ship site and the reference site, indicating that the communities were comparable. Differences in major taxonomic groups between the two sites were correlated with differences in sediment (grain size and total organic carbon). Cadmium, copper, nickel, and silver were present in the sediments. Cadmium was shown to bio accumulate in both the *Macoma* and *Nephytys*; copper bio accumulated in *Macoma* but not in *Nephtys*; and silver bio accumulated in *Nephtys* but not *Macoma*. The study of spatial distribution of PCBs indicated that the highest chemical concentrations and evidence of negative biological response was observed at stations that clustered near a large break in the hull at the rear of the ship, however, no statistically significant correlations were found. Investigators hypothesized that more chemical contaminants were released from the break in the ship and were deposited into sediments after the ship settled on the ocean bottom, resulting in an increase in exposed surface area inside of the hulk for leaching and/or particulate transfer of contaminants from shipboard materials to the environment. However, the results suggest that PCBs and other contaminants released from the vessel were localized and confined to areas within the immediate vicinity of the ship.

Further, based on the deep sea study with the ex-AGERHOLM, bottom water currents were determined to be minimal and likely do not contribute to the large scale movement of sediments. The study indicated that due to the presence of very low energy bottom currents relative to the dynamics associated with sorption and settling that would cause deposition into the sediments after any release of dissolved PCBs into the water column, any contaminants originating from the ex-AGERHOLM are not expected to differentially accumulative with directionality in the near hulk sediments (PEO, 2006b).

Tissues from sablefish were also sampled from the ex-AGERHOLM site and from reference locations four nautical miles away from the ship. Results of the testing showed that the sablefish from the ex-AGERHOLM had statistically higher concentrations (by a factor of 1.4 to 1.5) of PCBs than the sablefish from the reference area. Tissue residue benchmarks were developed to evaluate potential effects from exposure to Total PCBs and were based on the tissue screening value (TSV), bioaccumulation critical value (B_{CV}), and critical body residues (CBRs), which are chemical residue thresholds at or below which adverse toxicological effects would not be expected. Total PCBs in sablefish from the ship site were significantly higher than reference and three samples from the ship sites exceeded the most conservative benchmark (TSV) used in the analyses, however, no sample exceeded any of the less conservative benchmarks.. These results suggested that it was unlikely that exposure would be harmful to the deep sea pelagic community as a whole and there would be negligible risk to individual sablefish from critical body residues of Total PCBs.

In support of the ex-AGERHOLM findings, studies have shown that PCB bio magnification through the food chain may not occur due to factors such as feeding strategies, biochemical adaptations to depth, and differences in lipid and lipid types. Also, lower food chain levels (plankton and invertebrates consumed by fish) do not biomagnify to the extent observed in upper food chain species such as mammals and birds (Harding, 1986; Shaw and Connell, 1982). Consumption of contaminated food is the major source of chemicals for predatory birds and mammals. In contrast, the direct uptake of chemicals from water, sediment, and air is minor in comparison for upper food chain species (Nendza et al., 1997).

It should also be noted that since 1990, SINKEX ships have been more extensively cleaned, particularly for PCBs. Therefore the ex-AGERHOLM likely contained more PCBs-in solid materials (PCBs-ISM) than ships sunk after 1998 and it is likely that more recent SINKEX vessels will likely pose less risk from PCBs-ISM. Based on studies of the impacts of decommissioned vessels for the creation of artificial reefs in shallow water and the data generated for the ex-AGERHOLM in the deep ocean, is not expected that the removal and transport of LST-1166 from the Columbia River will adversely impact any endangered, threatened, or special status species identified in the project area or result in long-term effects on benthic or pelagic communities in the vicinity of the disposal site..

7.0 CONCLUSION AND DETERMINATION OF EFFECTS

In conclusion, we have determined that the proposed project will have no adverse effect on the species and critical habitat identified in Section 4.0 during the removal and transportation elements of the action or on the deep-water benthic and pelagic communities at the proposed disposal site.

This conclusion indicates that all effects are beneficial, insignificant, or discountable within the Columbia River and at sea. . As indicated in the effects evaluation, a majority of the wastes and paint have been removed and residual levels will be entombed following EPA's *National Guidance: Best Management Practices for Preparing Vessels Intended to Create Artificial Reefs* (EPA, 2006). As a result, through the use of BMPs, the potential for ecological exposure to vessel-related contaminants is expected to be minimal based on the multiple lines of evidence considered in this assessment.

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